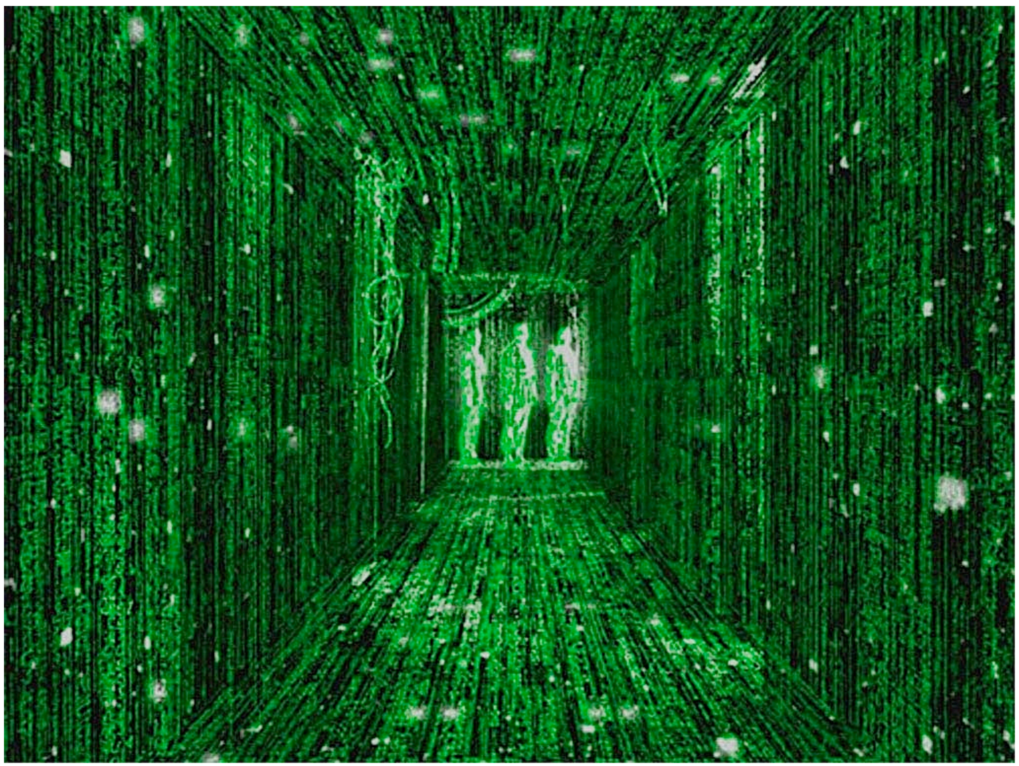
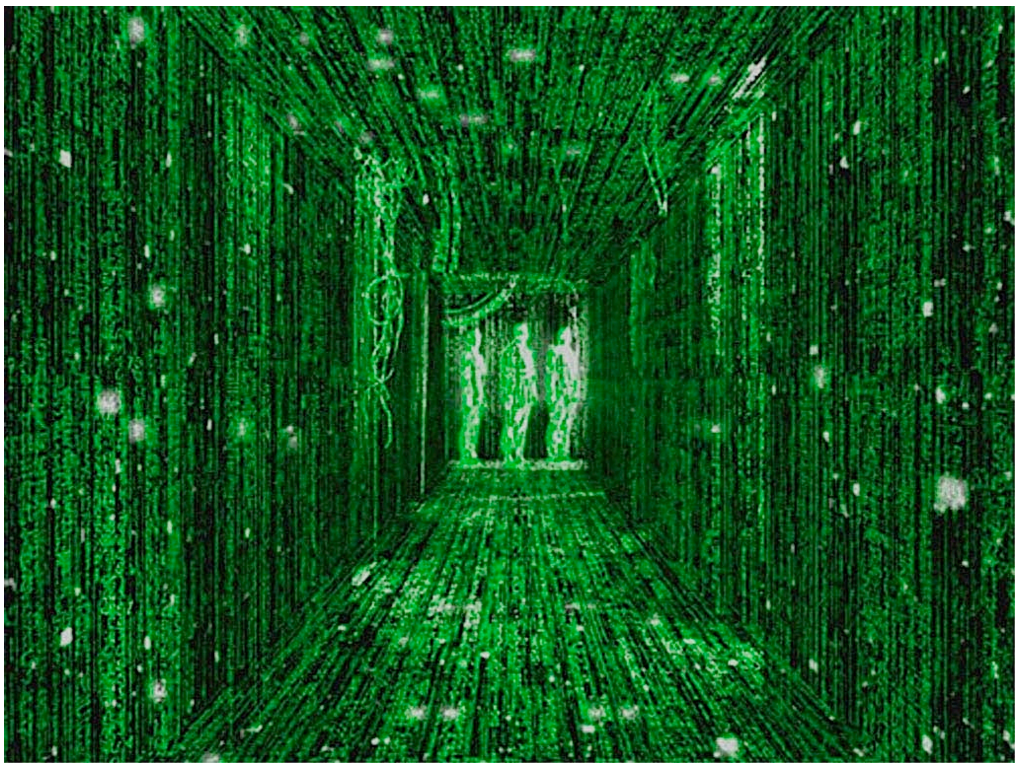
Exclusive Diffractive Vector Meson Production in eA: Finding the Source



Thomas Ullrich
October 4, 2012

BROOKHAVEN NATIONAL LABORATORY

Exclusive Diffractive Vector Meson Production in eA:
Finding the Source Distribution



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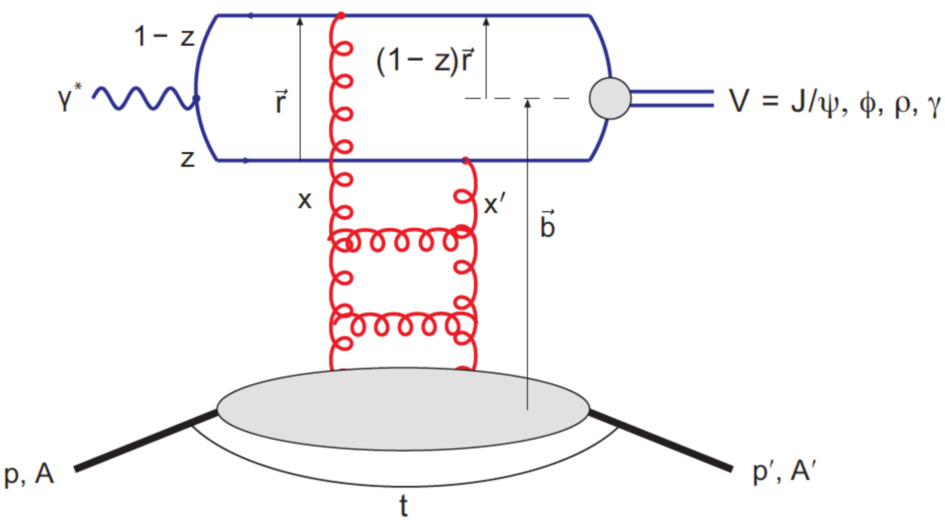
Reminder

e + A → e' + A + V where V=J/ψ, ϕ, ρ, γ

- Amplitude for producing an exclusive vector meson or a real photon diffractively is:

$$\mathcal{A}_{T,L}^{\gamma^* p \to V p}(x, Q, \Delta) = i \int \mathrm{d}r \int \frac{\mathrm{d}z}{4\pi} \int \mathrm{d}^2\mathbf{b}\, (\Psi_V^* \Psi)(r, z) \cdot 2\pi r J_0([1-z] r\Delta) \cdot e^{-i\mathbf{b}\cdot\Delta} \frac{\mathrm{d}\sigma_{q\bar{q}}^{(p)}}{\mathrm{d}^2\mathbf{b}}(x, r, \mathbf{b})$$



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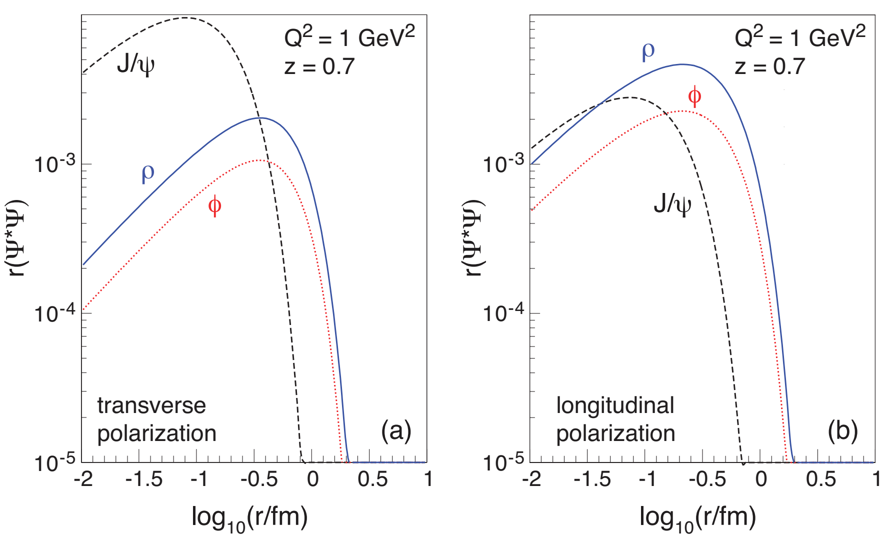

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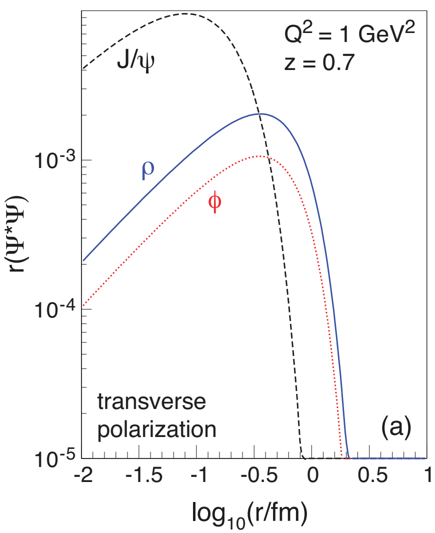

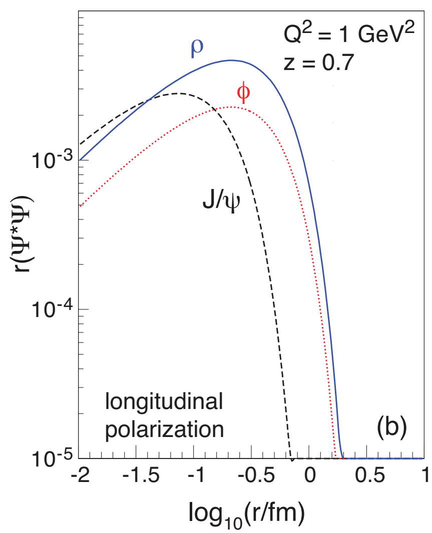

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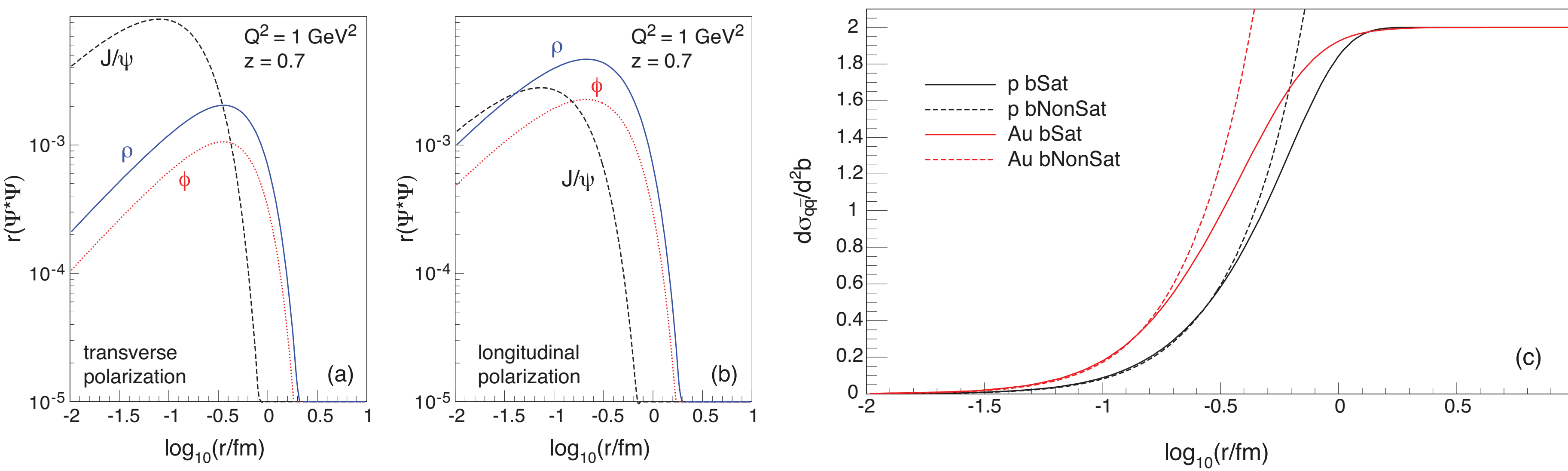
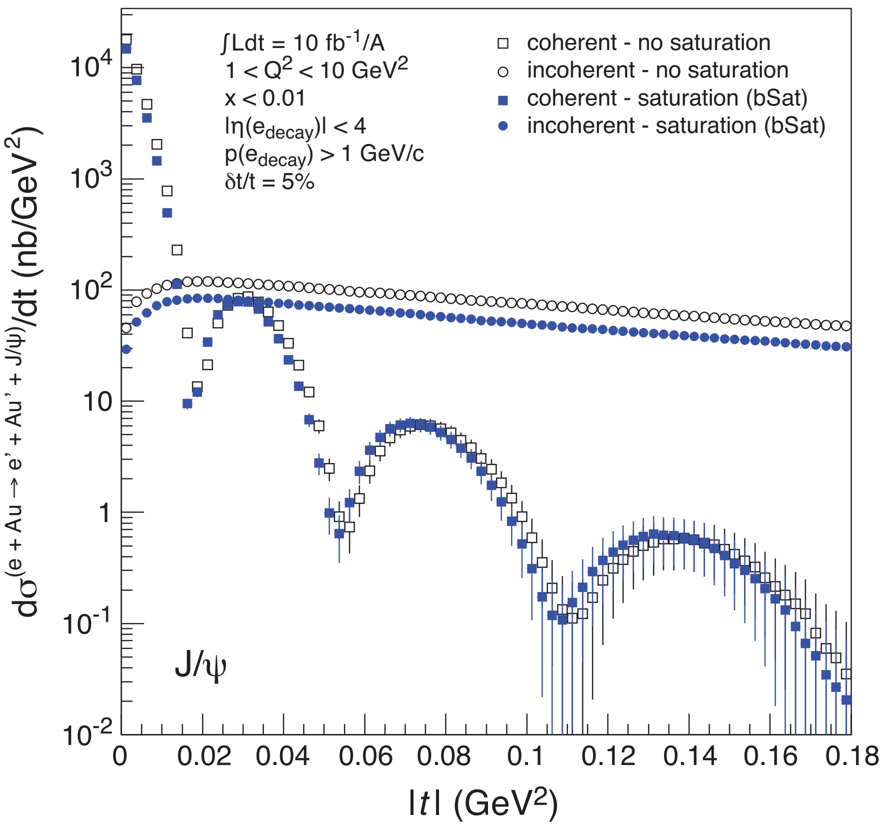
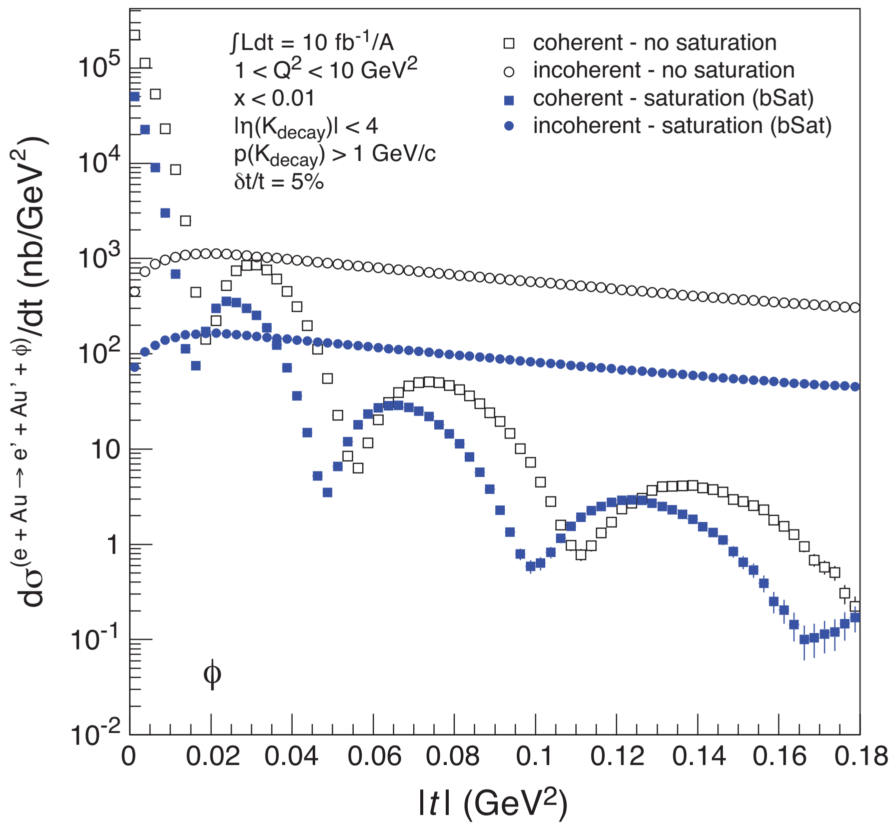


Starting Point





Reminder:

- e + Au → e' + Au + J/ψ: not sensitive to sat. effects
- e + Au → e' + Au + ϕ: larger wf ⇒ sensitive to sat. effects
- Sartre: uses Woods-Saxon to generate nuclei

Getting Source Distribution from dσ/dt

Markus Diehl (INT '10):

$$F(b) \sim \frac{1}{2\pi} \int_0^\infty d\Delta\, \Delta\, J_0(\Delta b) \sqrt{\frac{d\sigma}{dt}}$$

$t = \Delta^2/(1-x) \approx \Delta^2$ (for small x)

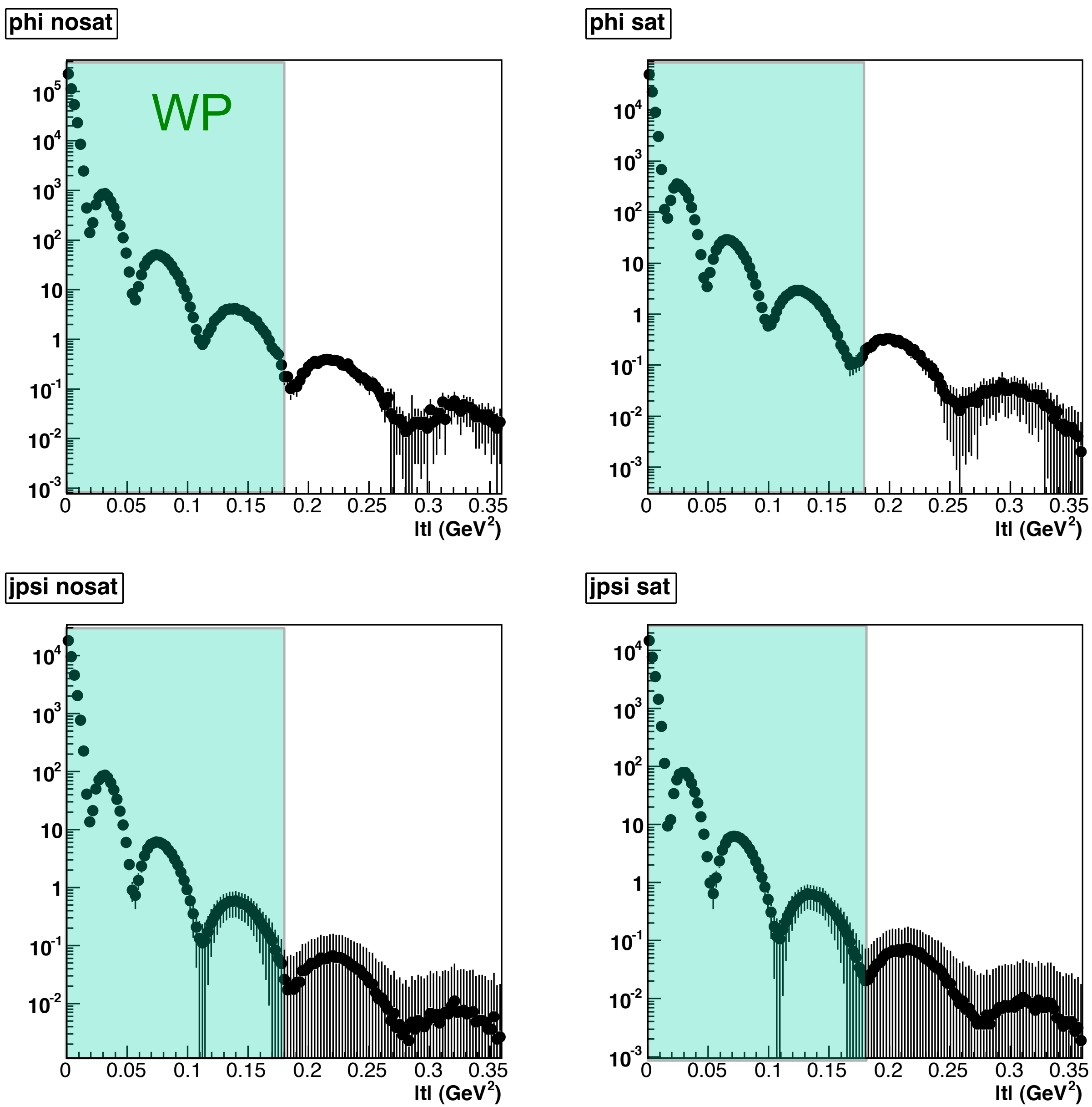
Issues (ep):

- Measured range in Δ
- Statistical errors on data

What about eA?

- WP: only shows dσ/dt for $t<0.16$ GeV^2
- Available simulations extend to $t=0.36$ GeV^2
- Is this enough to extract a reasonable F(b)?
- Are errors even at 10 fb^{-1} a killer?

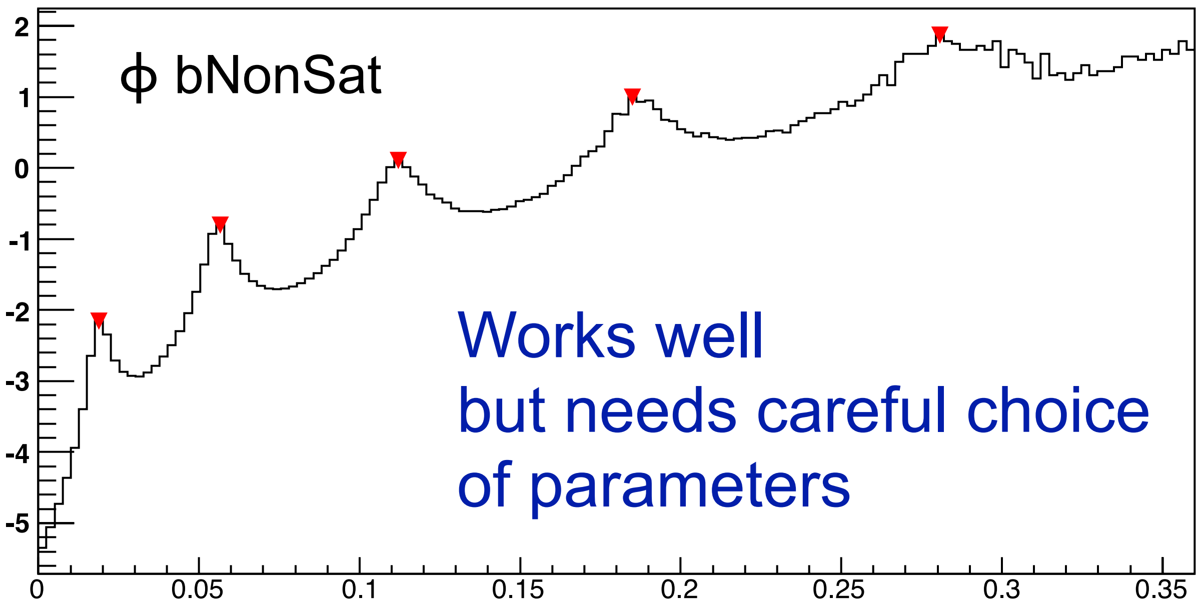
Available Data from Sartre (100M each)



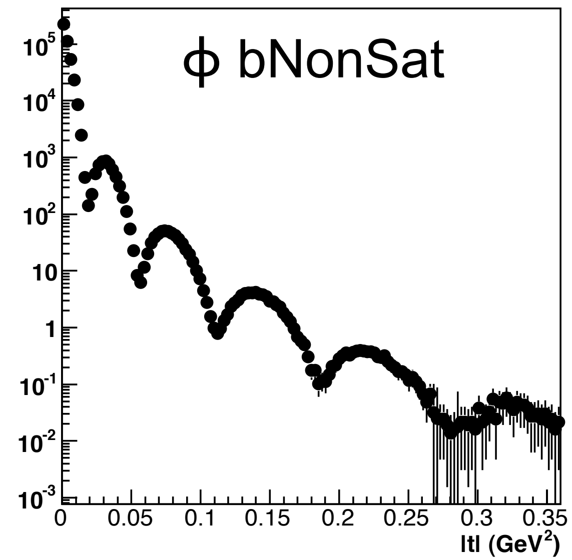
Practical Issues

For integration: Sign flip in $J_0(\Delta b)$?

Use ROOT::TSpectrum::Search package:



Works well
but needs careful choice
of parameters

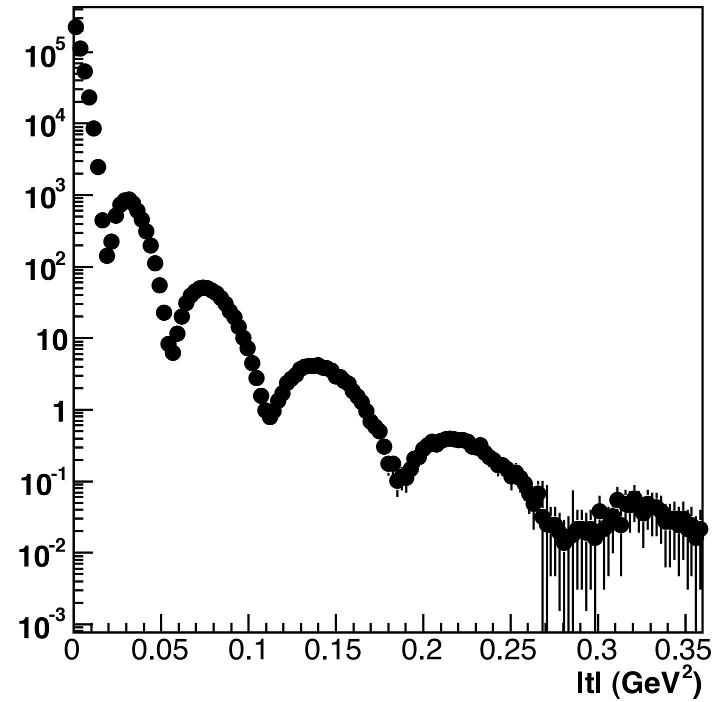


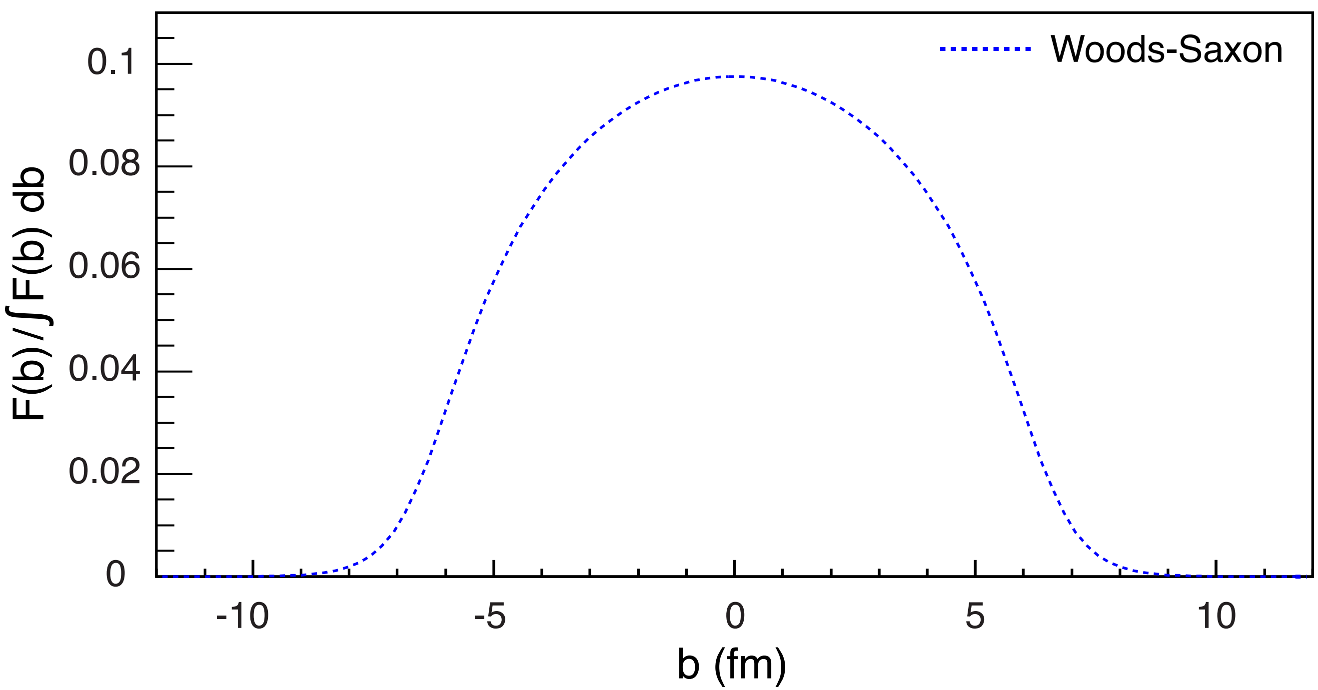
Integration routines have their issues with Bessel functions

Use GSLIntegration (best available) - makes a difference!

t-Range

- ϕ bNonSat:
  - No saturation effects expected
  - In ideal world: should get original Woods-Saxon back





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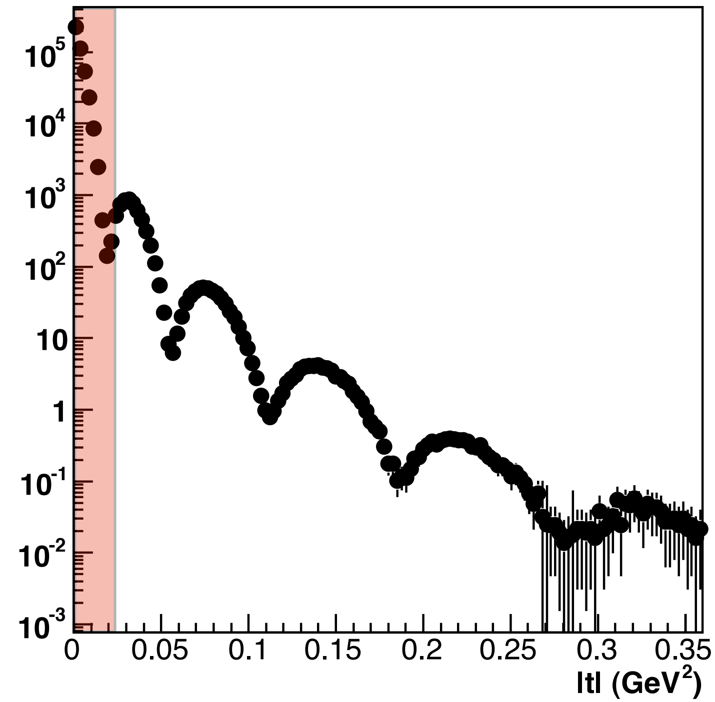

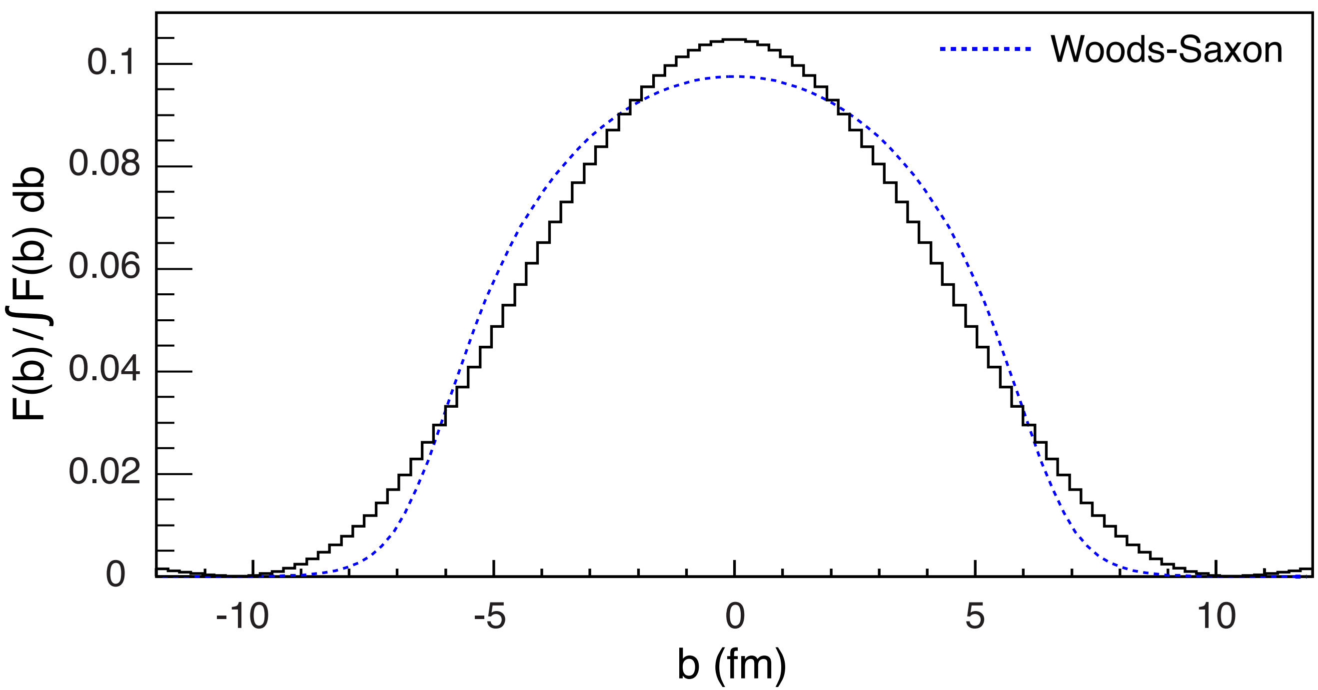

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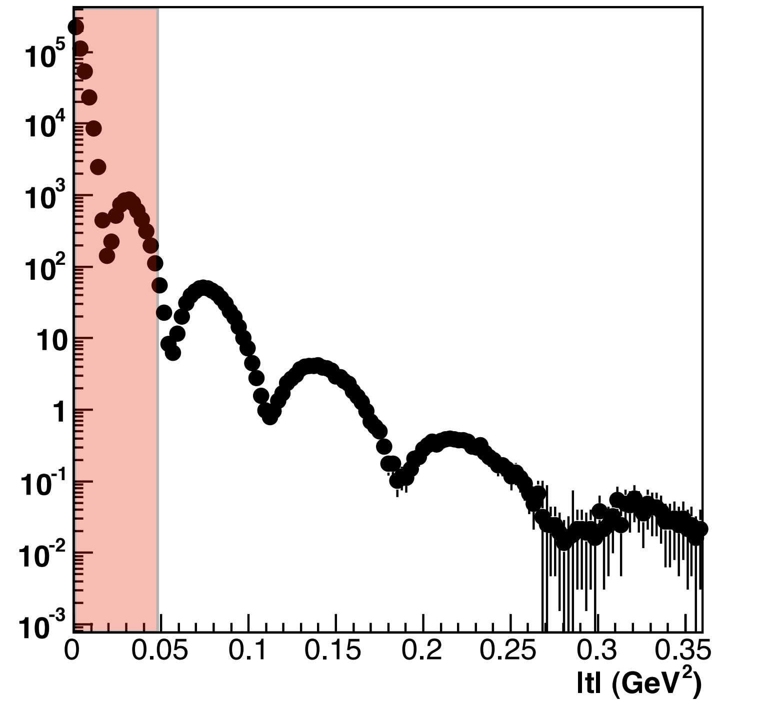

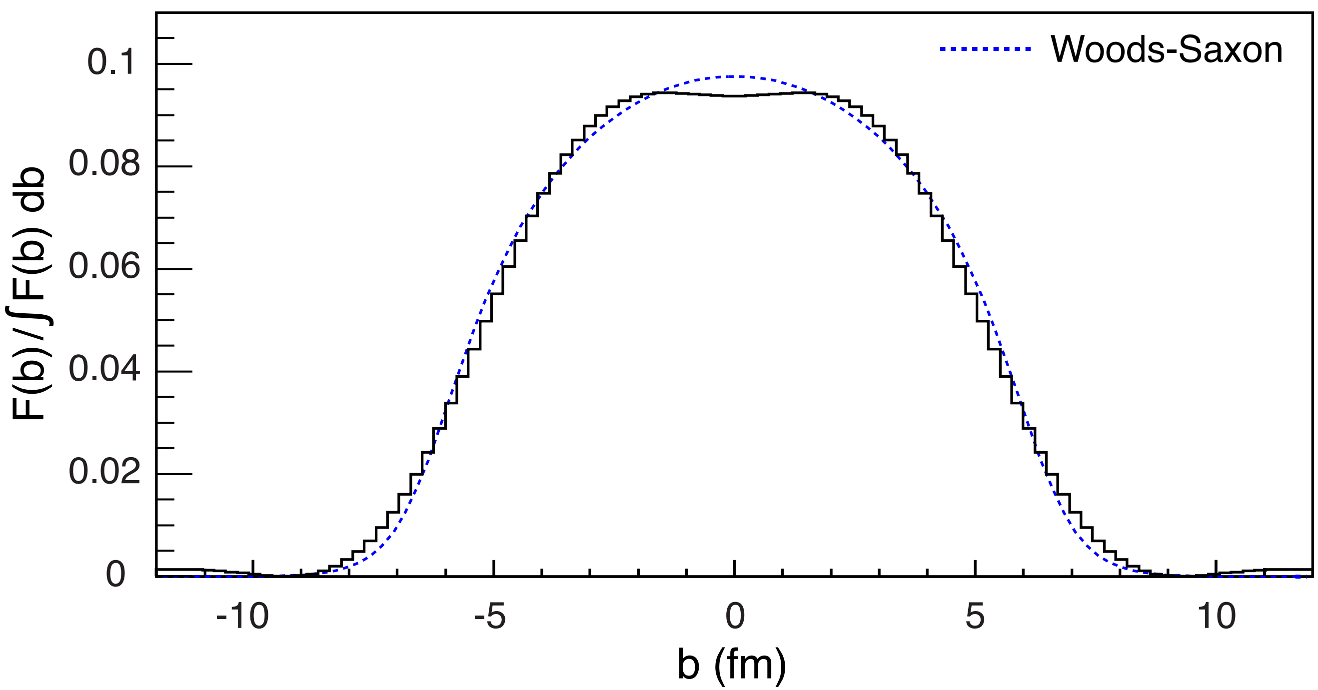

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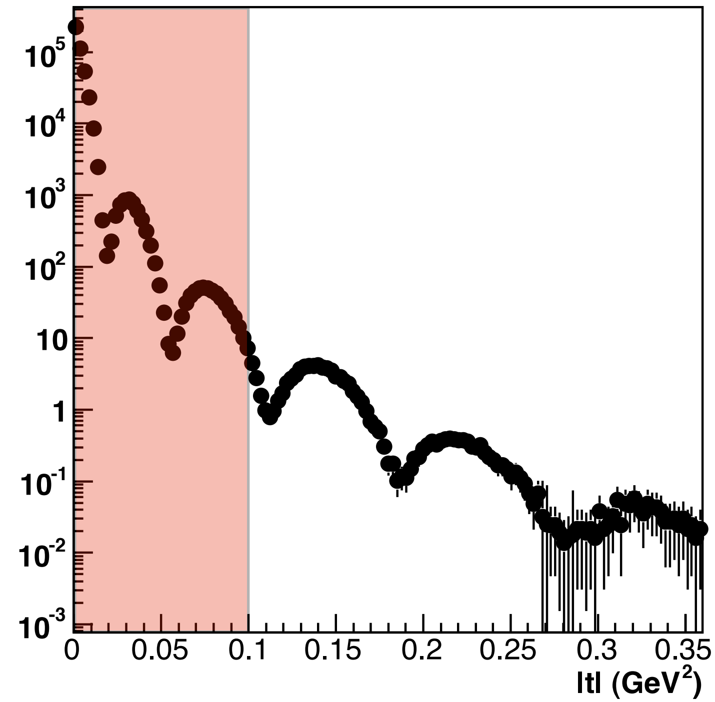

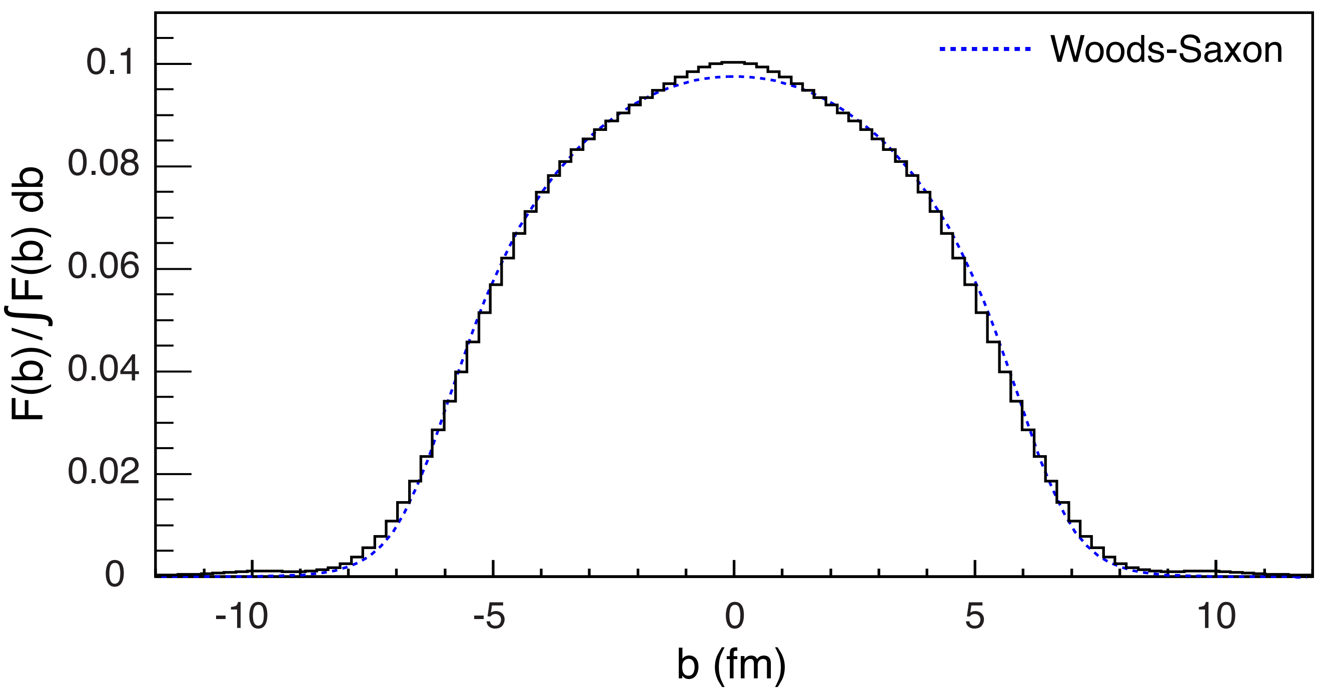

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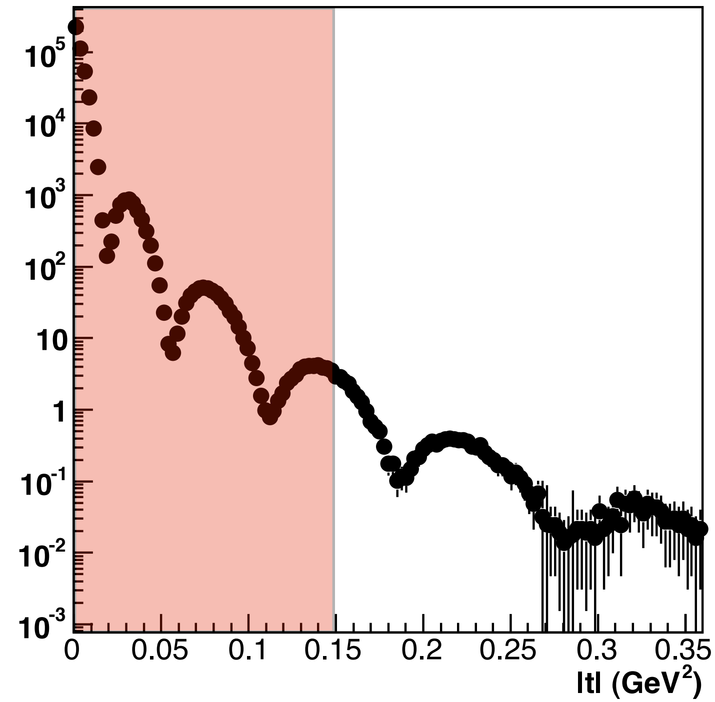

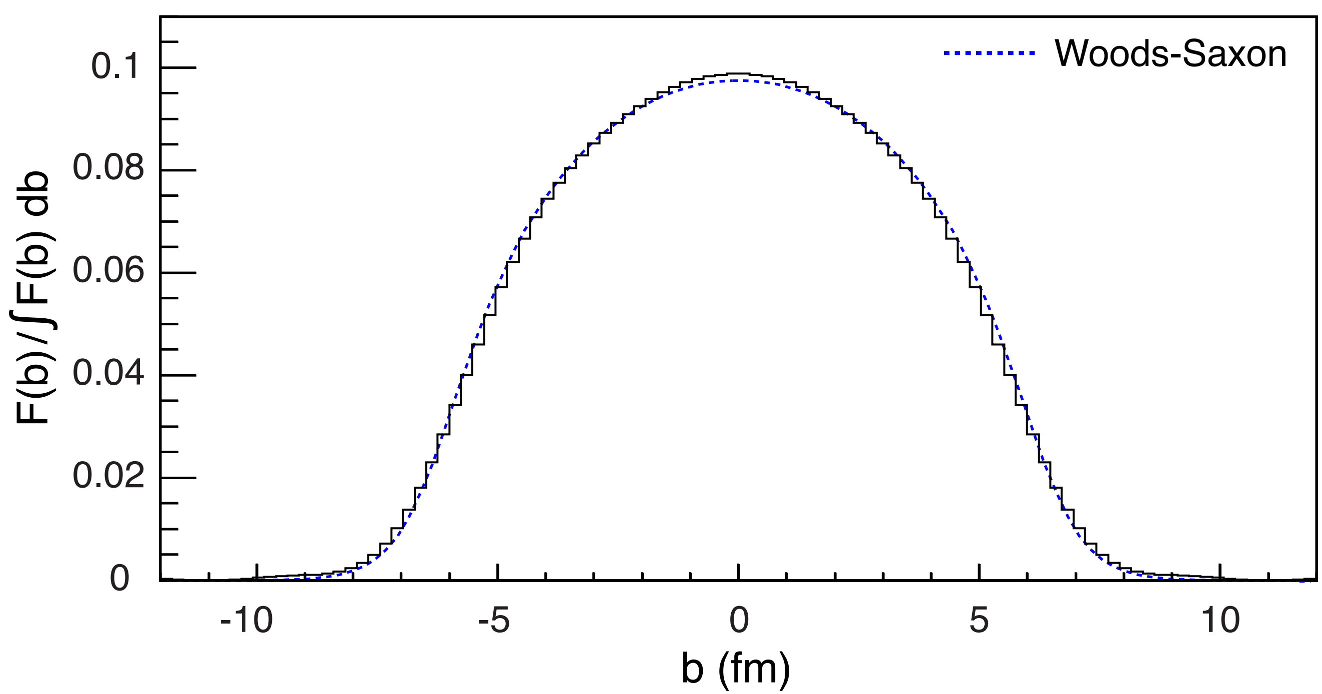

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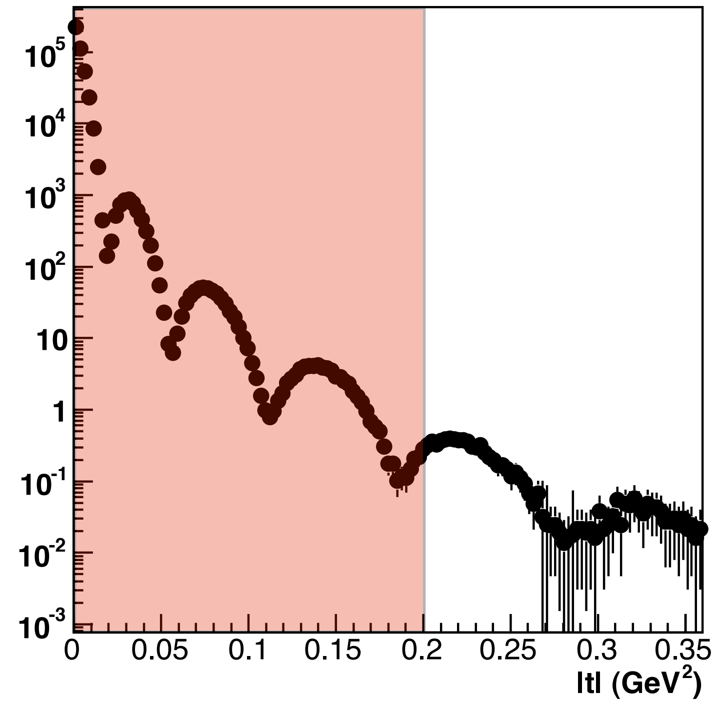

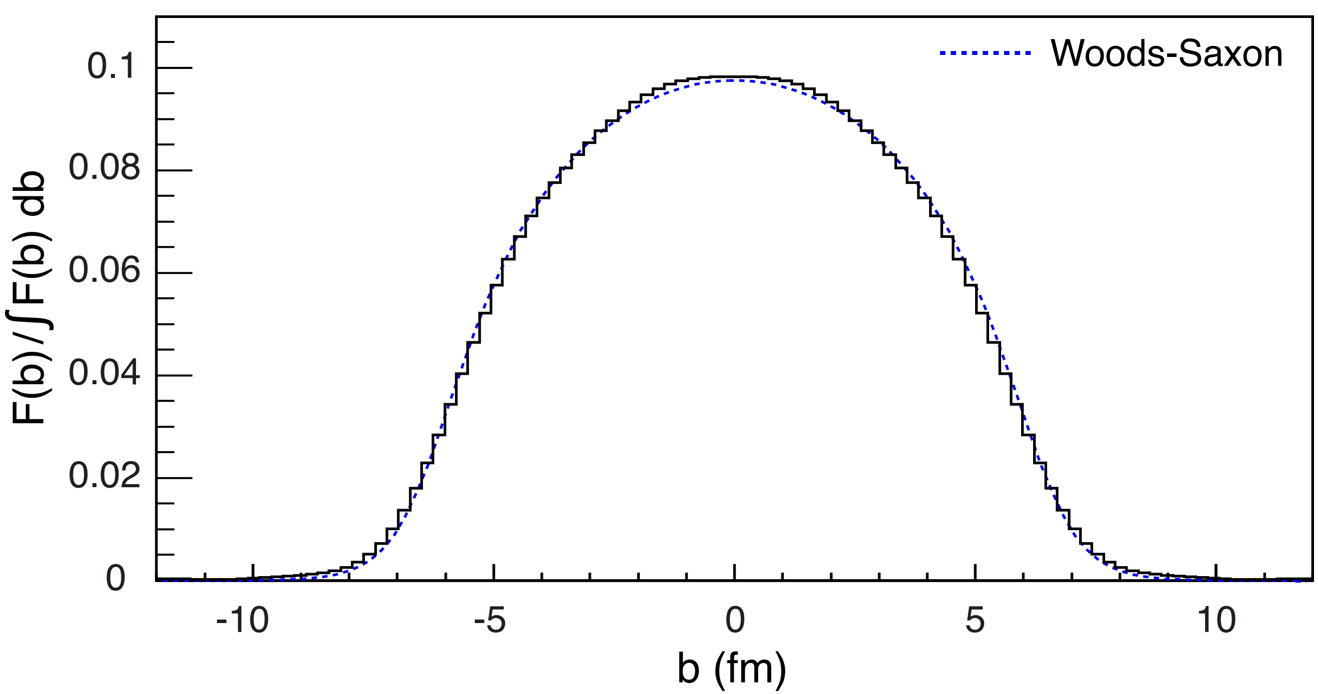

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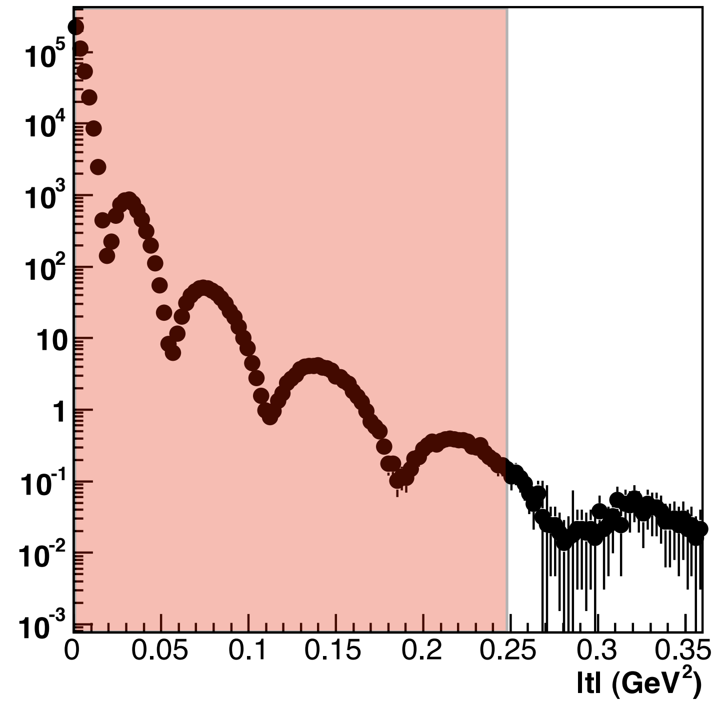

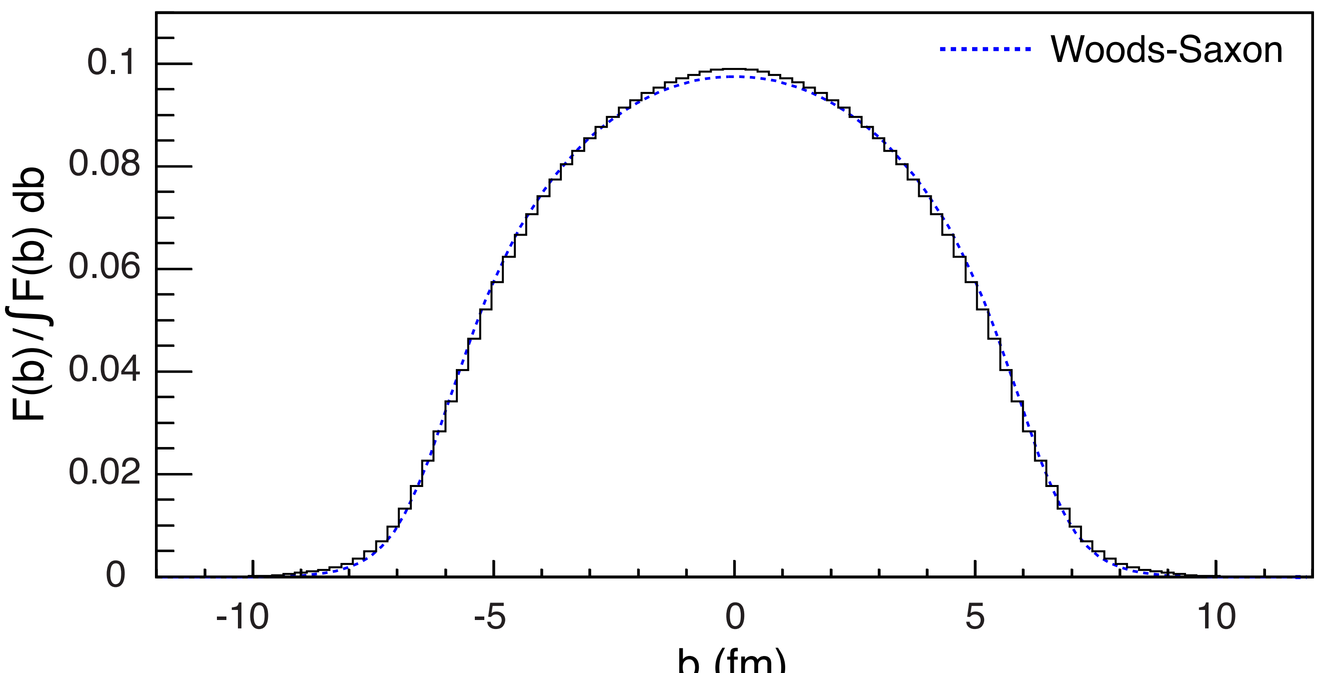

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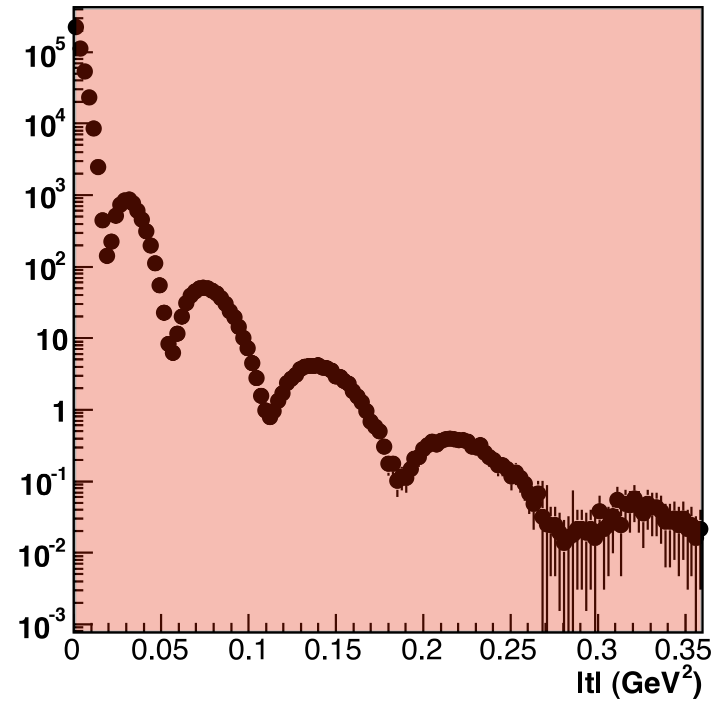
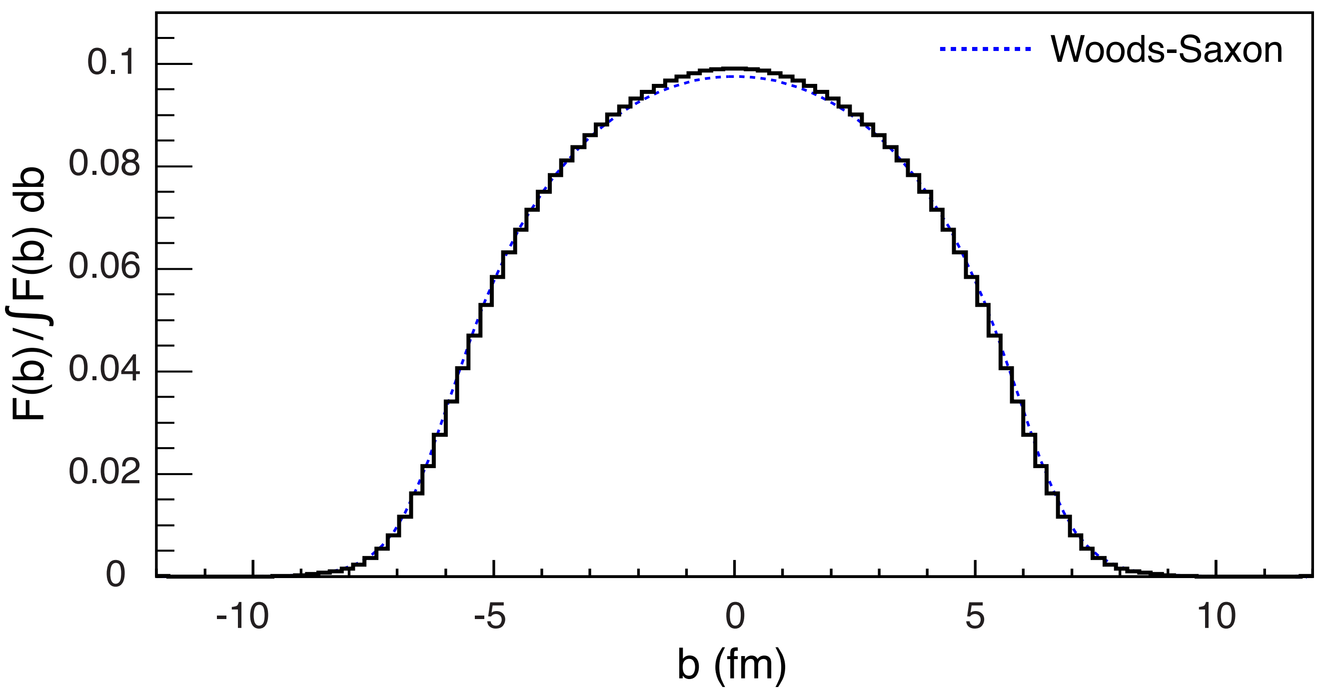
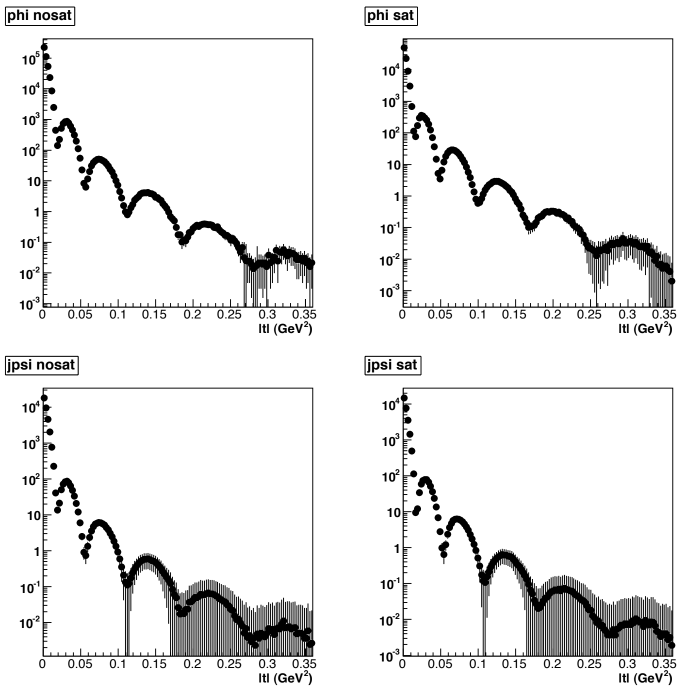




Error Band?



Use 2 extremes:

1. $d\sigma/dt|_{upper} = d\sigma/dt + error(t)$
2. $d\sigma/dt|_{lower} = d\sigma/dt - error(t)$

Run both through same procedure as curve itself. In each bin pick min and max of ($d\sigma/dt$, $d\sigma/dt|_{lower}$, $d\sigma/dt|_{upper}$) $\Rightarrow$ error band

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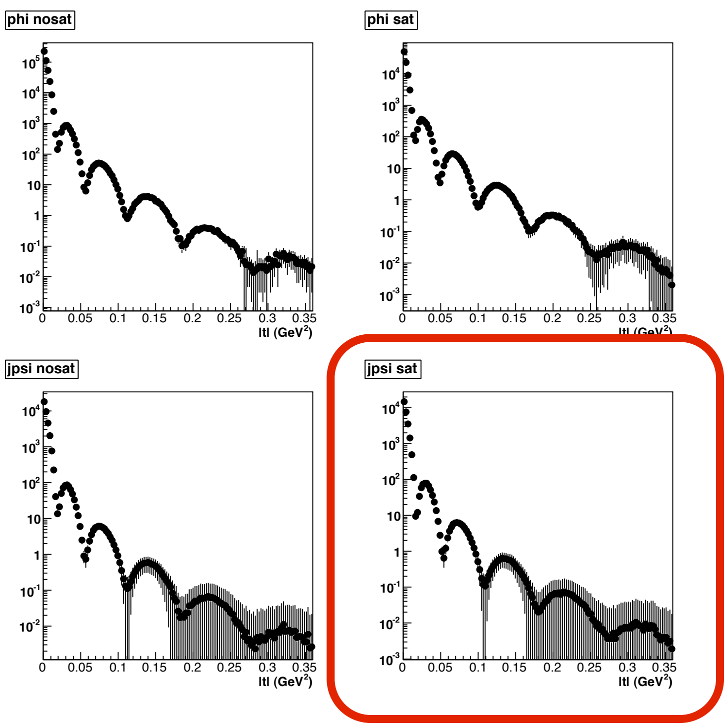

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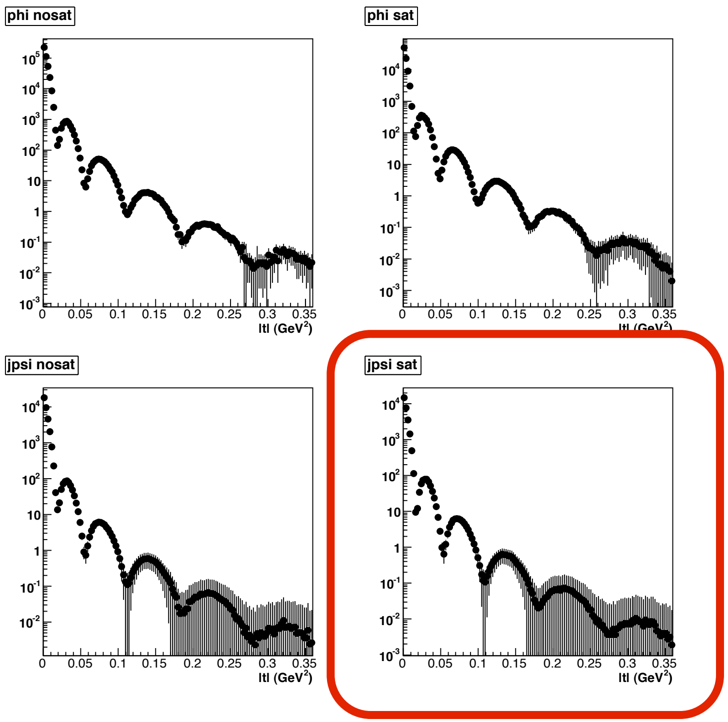

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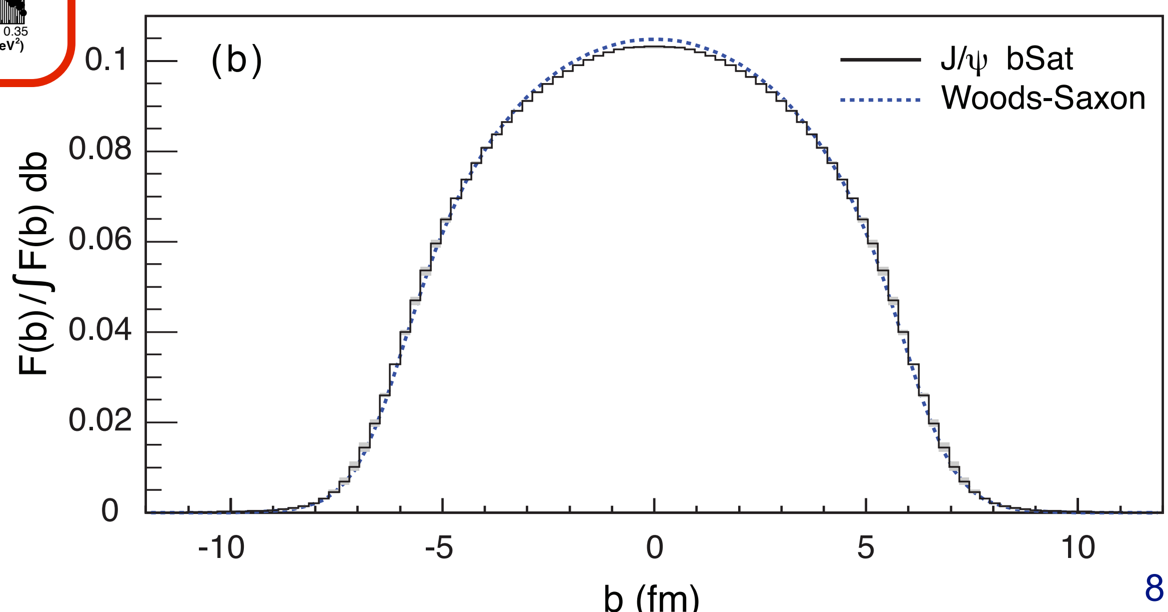
Here J/psi sat:

$\Rightarrow$ tiny errors

$\Rightarrow$ almost invisible



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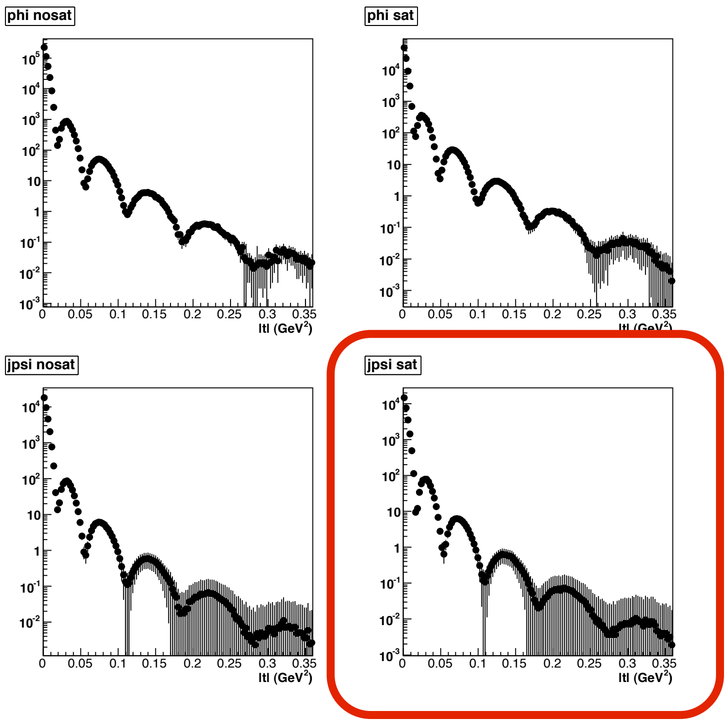

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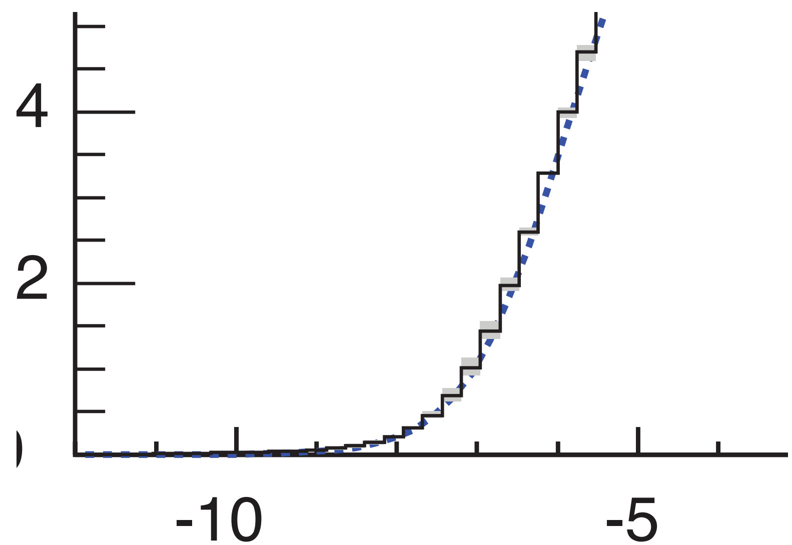
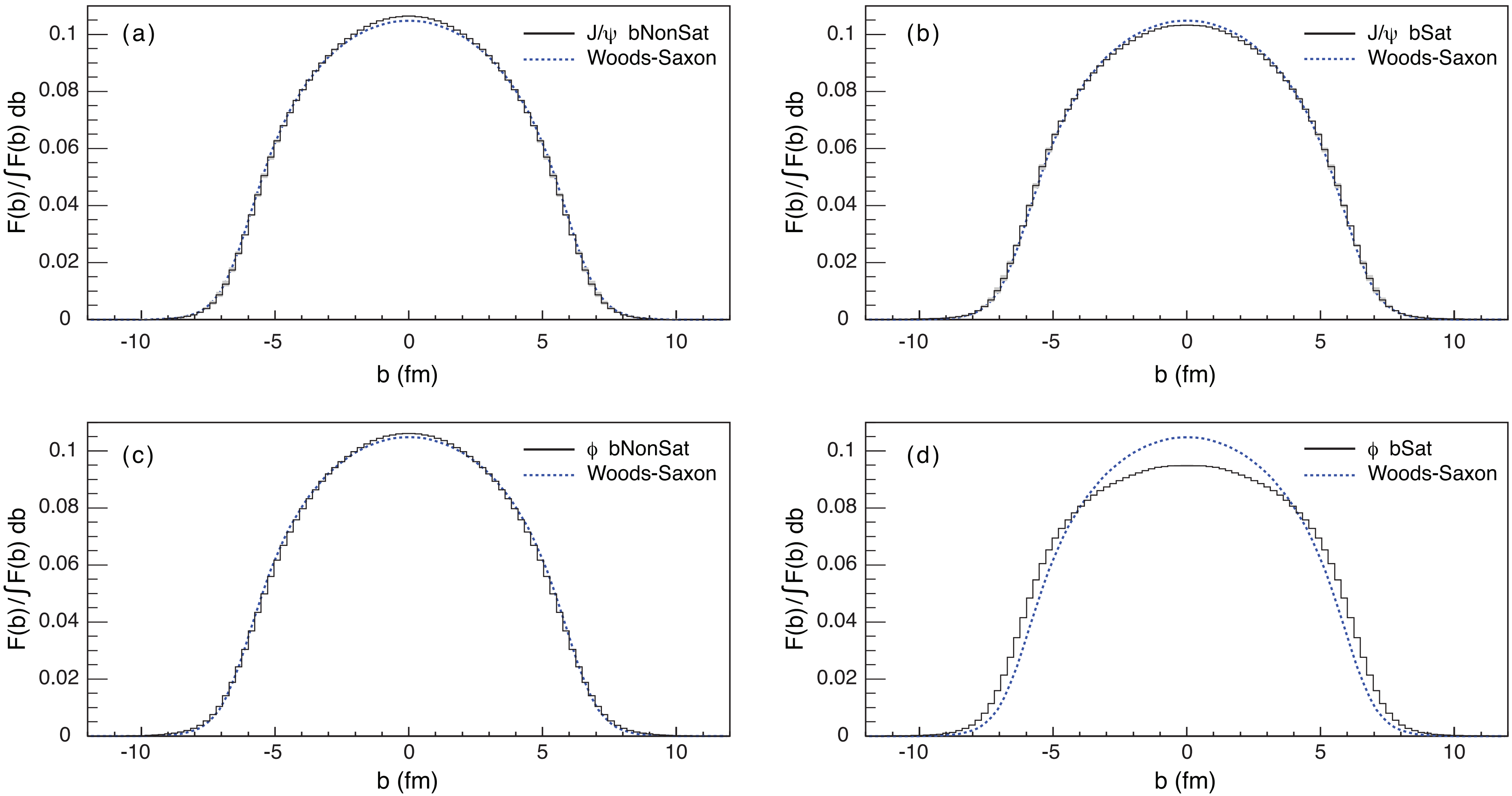


Results for all Data Sets



Summary

$d\sigma/dt \rightarrow F(b)$

- works better than expected
- $-t < 0.2\ \mathrm{GeV}^2$ is more than enough
- little sensitivity for errors (at $10\ \mathrm{fb}^{-1}$)
- J/ψ appears to be the best probe for $F(b)$ independent of saturation effects or not
- ϕ shows saturation/coherence effects
  - OK as a signature for saturation
  - not so good for studying $F(b)$